11/659793
IAP8 Rec'd PCT/PTO 09 FEB 2007

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

LARSSON et al — Atty. Ref.: 4208-51

National Phase of PCT/EP2004/014668
International Filing Date: 23 December 2004
Serial No. to be assigned — TC/A.U.: unknown

Filed: February 9, 2007 — Examiner: unknown

For: METHOD AND ARRANGEMENT IN WIRELESS AD HOC OR MULTIHOP NETWORKS

* * * * * * * * * * *

February 9, 2007

Mail Stop Petition
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Adjustment date: 03/06/2007 SBASHEIR
02/12/2007 GFREY1 00000141 11659793
01 FC:1453 -1500.00 OP

Sir:

PETITION TO REVIVE UNINTENTIONALLY ABANDONED APPLICATION

Due to a delay in entering the national phase, the above identified application was unintentionally abandoned. The entire delay from when the national phase was scheduled to be filed and the filing of this application was unintentional. This statement conforms to the statement required by 37 C.F.R. §1.137(b)(1).

Applicant encloses herewith the petition fee in the amount of $1500.00as required by 37 C.F.R. § 1.137(b)(3).

02/12/2007 GFREY1 00000141 11659793
01 FC:1453 1500.00 OP

Having met all of the requirements set forth in 37 C.F.R. § 1.137(b)(1-3), it is respectfully requested that the above identified National Phase application be revived,

that a filing receipt be forwarded and the application sent for further prosecution in the U.S. Patent and Trademark Office.

Respectfully submitted,

NIXON & VANDERHYE P.C.

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IAP13 Rec'd PCT/PTO 09 FEB 2007

FORM PTO-1390 MODIFIED	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER **4208-51**
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5) 11/659793 ~~to be assigned~~
INTERNATIONAL APPLICATION NO. **PCT/EP2004/014668**	INTERNATIONAL FILING DATE **23 December 2004**	PRIORITY DATE CLAIMED **30 December 2003**

TITLE OF INVENTION
METHOD AND ARRANGEMENT IN WIRELESS AD HOC OR MULTIHOP NETWORKS

APPLICANT(S) FOR DO/EO/US
LARSSON et al

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a submission under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a submission under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The U.S. has been elected (Article 31).
5. A copy of the International Application as filed (35 U.S.C. 371(c)(2).
   a. ☒ is attached hereto (22 pages specification, claims & abstract (30 claims), 4 sheets drawings).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(3))
   a. ☐ is attached hereto (pages specification, claims & abstract (claims), sheets drawings, page Certificate of Translation).
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has **NOT** expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3).
9. a. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4).
   b. ☐ Declaration was submitted to the International Bureau during International Phase (see copies of Declaration (page Form PCT/RO/101 and Form PCT/IB/371 and first page of printed publication acknowledging receipt thereof attached).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5).

Items 11 To 20 below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included.
13. a. ☒ A FIRST preliminary amendment.
    b. ☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ An Application Data Sheet under 37 C.F.R. § 1.76.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 37 CFR 1.821-1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information. International Preliminary Report on Patentability w/amended sheets and International Search Report; Petition to Revive Unintentionally Abandoned Application; Request for Transfer of Funds

IAP8 Rec'd PCT/PTO 09 FEB 2007

Mail Stop PCT

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
11/659793 to be assigned	PCT/EP2004/014668	4208-51

☒ The following fees are submitted:

BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5):

21. ☒ Basic national fee	$300.00 (1631)/$150.00 (2631)	$	300.00
22. ☒ Examination Fee	$0 (1643/2643)		
	$200.00 (1633)/$100.00 (2633)	$	200.00
23. ☒ Search Fee	$0 (1640/2640)		
	$100 (1641)/$50 (2641)		
	$400 (1642)/$200 (2642)		
	$500.00 (1632)/$250.00 (2632)	$	400.00
	TOTAL OF ABOVE CALCULATIONS	$	900.00

☐ Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing or computer program listing filed in an electronic medium). The fee is **$250** for each additional 50 sheets of paper or fraction thereof.

Total Sheets	Extra Sheets		Number of each additional 50 or fraction thereof (round **up** to a whole number		RATE		
26 -100	0	/50 =	0.00		**$250.00** (1681) **$125.00** (2681)	$	

Surcharge of **$130.00** (1617)/**$65.00** (2617) for furnishing the oath or declaration later than ☒ 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e).	$	130.00

CLAIMS	NUMBER FILED		# EXTRA	RATE			
Total Claims	25	minus 20 =	5 X	$50.00 (1615)/	$25.00 (2615)	$	250.00
Independent Claims	3	minus 3 =	0 X	$200.00 (1614)	$100.00 (2614)	$	
MULTIPLE DEPENDENT CLAIMS(S) (if applicable)				$360.00 (1616)/$180.00 (2616)		$	0.00

Petition is hereby made to extend the current due date so as to cover the filing date of this paper and attachment(s): One Month Extension $120.00 (1251)/$60.00 (2251); Two Month Extensions $450.00 (1252)/$225.00 (2252);Three Month Extensions $1020.00 (1253/$510.00 (2253); Four Month Extensions $1590.00 (1254/$795.00 (2254)	$	0.00
☐ Applicant claims small entity status. See 37 CFR 1.27.		
Processing fee of **$130.00** (1618), for furnishing the English Translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 C.F.R. 1.492(f). +		0.00
TOTAL NATIONAL FEE =	$	**1280.00**
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). **$40.00** (8021) per property +	$	0.00
Fee for Petition to Revive Unintentionally Abandoned Application;**$1500.00** (1453) / **$750.00** (2453)	$	1500.00
TOTAL FEES ENCLOSED =	$	**1500.00**
PLEASE SEE SIMULTANEOUSLY FILED "REQUEST FOR TRANSFER OF FILING FEES" FOR BALANCE OF FEES DUE, AND IF TRANSFER IS NOT EFFECTIVE PLEASE CHARGE ACCOUNT PER BOX "c" BELOW	Amount to be: refunded:	$
	Amount to be Charged:	$

a. ☐ A check in the amount of $2780.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. 14-1140 in the amount of $_____ to cover the above fees. A duplicate copy of this form is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 14-1140. A duplicate copy of this form is enclosed.

d. ☒ **CREDIT CARD PAYMENT FORM ATTACHED.**

e. ☒ The entire content of International Application No. **PCT/EP2004/014668** and any U.S. and foreign application(s) corresponding thereto, and SE 0303584-7 and EP 04015198.7, referred to in this application is/are hereby incorporated by reference in this application.

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b) must be filed and granted to restore the application to pending status.

CORRESPONDENCE ADDRESS

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H. Warren Burnam, Jr.
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29,366
REGISTRATION NUMBER

February 9, 2007
Date

1169673

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

LARSSON et al — Atty. Ref.: 4208-51

National Phase of PCT/EP2004/014668
International Filing Date: 23 December 2004
Serial No. to be assigned — TC/A.U.: unknown

Filed: February 9, 2007 — Examiner: unknown

For: METHOD AND ARRANGEMENT IN WIRELESS AD HOC OR MULTIHOP NETWORKS

* * * * * * * * * * *

February 9, 2007

Mail Stop Petition
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

REQUEST FOR TRANSFER OF FILING FEES

Applicants filed an untimely national stage application of PCT/EP2004/014668 on July 12, 2006, which has been afforded U.S. Serial Number 10/585,787. For U.S. Serial Number 10/585,787 Applicant has paid fees totaling $1280.00 ($300 (1631), $200 (1633), $400 (1632), $130 (1617), $250 (1615)).

Applicants have today filed a Petition to Revive Unintentionally Abandoned Application with Petition fee to afford priority of the earliest priority date for the captioned PCT application.

Applicants request a transfer of the $1280.00 filing fees paid on July 12, 2006 for Serial No. 10/585,787 to be used for filing fees for the captioned application, and abandonment of Serial No. 10/585,787 (such abandonment to occur only if the transfer is approved).

If transfer is not possible, the Commissioner is authorized to charge the undersigned's deposit account #14-1140 in whatever amount is necessary for entry of these papers, the revival, and the continued pendency of the captioned application.

Respectfully submitted,

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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

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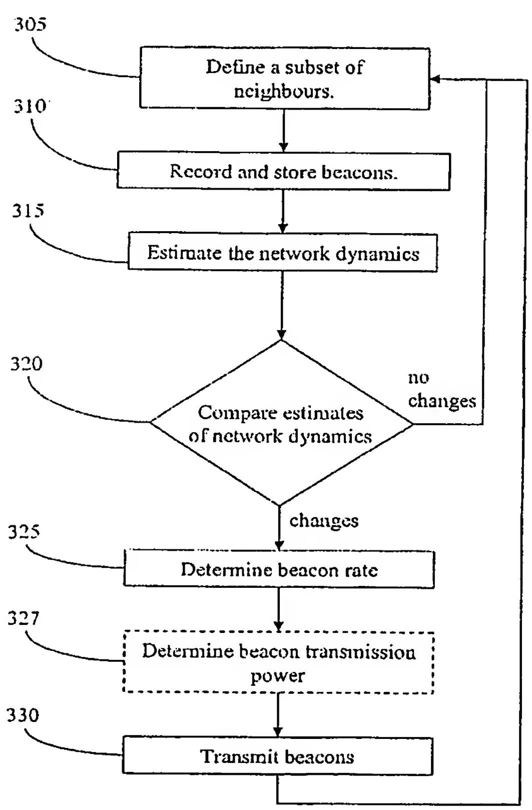
[Continued on next page]

(54) Title: METHOD AND ARRANGEMENT IN WIRELESS AD HOC OR MULTIHOP NETWORKS



(57) Abstract: The present invention relates to the use of beaconing or "hello" messages in wireless multihop or ad hoc communication networks. In the method according to the present invention beacon messages (HELLO messages) are transmitted between a plurality of radio nodes (205, 215) in an ad hoc or multihop network. The rate of which the radio nodes transmit their beacons is based on an estimate of the network dynamics. Also the transmit power of the beacons are preferably based on an estimate of the network dynamics. The radio nodes bases their estimate of the network dynamics on beacons received from neighboring radio nodes.

WO 2005/064863 A1

ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD AND ARRANGEMENT IN WIRELESS AD HOC OR MULTIHOP NETWORKS

Field of Invention

The present invention relates to wireless multihop or ad hoc communication networks. In particular, the present invention relates to the use of beaconing or "hello" messages in such networks.

Background of the Invention

The concepts of self-organising wireless networks for mobile communication has been known since the seventies, at least, but the research and uses of such systems were in the early years restricted to military and emergency applications. The potential of the systems for all kinds of communication were surly recognized, but the cost of the equipment and the complexity of the systems caused the use to be very limited.

In recent years, the interest in self-organising networks have seen a significant interest. Some of the driving forces being the wish to provided various types of communication to a large variety of devices, the understanding that all devices does not need to have long range wireless communication capabilities if they instead can communicate over short range with another device which has long range wireless communication capabilities and the increased use of mobile equipment such as laptop computers, personal digital assistants (PDA), and digital cameras, equipment which would clearly increase their usefulness if possible to communicate with/from also then not in their "home environment" and not at least the existence of the Internet providing a reason for such communication to be sought for. At the same time has the technology evolved with regards to transceivers, batteries, radio transmission techniques- it has become technical feasible and economically justifiable to provide a large number of different types of devices with means for wireless communication, for example transceivers, coders/decoders etc. Ad hoc networks and Multihop networks are among the self-organising networks that have drawn major attention. In this type of networks, a plurality and preferably all mobile nodes, for example a cellular phone/mobile terminal, a PDA or a Laptop, are capable of operating as a radio base station or router (mobile host) for other mobile nodes. The need for a fixed infrastructure is thus eliminated, though access to a

fixed network, such as Internet, is a good complement to a fully ad hoc operation. Accordingly, data packets being sent from a source mobile node to a destination mobile node is typically routed through a number of intermediate mobile nodes (multi-hopping) before reaching the destination mobile node. An Ad hoc network is typically completely self-organising in that the routing paths (hopping sequence) are not predetermined in any way, although elaborate optimization routines may be used to find the best paths. Ad hoc networks generally uses multihopping. Multihop networks may have some predetermined preferred hopping schemes, i.e. a multihop networks is not necessarily an ad hoc network.

The nodes in the network typically keeps a preferably recently updated routing table, specifying mobile nodes which the present node is able to send a data packets to. In a multihop network, using data packet routing or similar, the following procedure is performed for each packet being routed: When a node receives a packet, it checks its routing table for the next hop node leading the data packet towards destination. If the receiving node does not have any next hop node, and is not the destination, then routing table state is inconsistent in the multihop network. To update the state, the receiving node may e.g. initiate a route search to the destination, wait until the state is updated automatically (may be performed on a regular basis), or simply respond to the previous station that it does not have a correctly operating route, and said previous station may try another route. The latter case does however not really solve the full problem, but slightly alleviates it.. The process continues until the data packet eventually reaches the destination node. Alternatively, no routing lists are kept in the mobile nodes and the routing paths are established per session. The routing procedures and updating of routing lists can be performed in a great variety of ways, and many are reported in the art.

The ad hoc and multihop networks today envisaged, do not only provided communication between mobile nodes of different kind, but also enables the mobile nodes to access fixed networks and thus communicate with other types of terminals, get access to information on databases and download files for information or entertainment etc. The fixed networks comprise the public switched telephone network (PSTN), public land mobile network (PLMN), local area networks (LAN) and Internet. A comprehensive description of ad hoc and multihop networks are given in "Wireless ad hoc networking- The art of networking without a network", by M. Frodigh et al, Ericsson Review, pp 248-263 (4) 2000. An exemplary ad hoc network is shown in FIG. 1, comprising mobile nodes such as mobile terminals 105, PDAs

105, laptops 110, and other equipment provided with communication devices such as digital cameras 115, as well as communication networks such as a LAN 120, provided with an wireless access point 125, and a wireless cellular communication network 130 adapted for GPRS. These networks are typically interconnected to Internet or a corporate IP network via routers 140. The mobile nodes form personal area networks 135 (PAN), in which they communicate and mobile nodes in the different PANs connect to nodes in other PANs and to the other communication networks. Thereby each mobile node has the possibility to communicate with all other nodes and the communication networks through multihopping.

The organisation and optimization of ad hoc and multihop networks are far from trivial. An ad hoc or multihop network can, during certain circumstances, produce extensive signalling that is not productive in that is does not deliver payload data to the destination. Optimization of ad hoc networks has shown to be necessary to save the radio resources and power i.e. in most cases battery life. Due to the mobility of the nodes the topology of the network may change frequently and in an unpredictable way. Furthermore, devices may suddenly be switched on or off (or go into some sleep mode), causing new links to appear or existing links to vanish. Routing in such a dynamic environment is a difficult task. A large research activity is to be found in this field, and manifested in e.g. the WIPO publications WO 02/35779 and WO 03/079611. The power concerns are established in the above-referred Ericsson Review publication. WO 02/35779 teaches a method of performing the multi-hopping in an effective way by considering and exchanging the "cost" of forwarding a data packet to its destination. Taught in WO 03/079611 are methods for adapting the power used in a transmission based on estimates of path loss and noise level.

To be able to perform routing and keep connections alive in this environment mobile nodes (as well as generally also in fixed networks) exchange so called beacon messages (or HELLO messages) in the form of small packets. In some cases nodes use the beacons also to maintain a table of one-hop route entries for each neighbouring node, e.g. allowing the nodes to perform route setup and route maintenance. Optimization algorithms generally depend heavily on the result of the beaconing. Beaconing is especially important when performing Quality of Service QoS routing since good knowledge of the topology is a necessity in this case. Beacons may also be used for neighbour discovery, synchronisation (after receiving a

beacon frame, a station uses the timestamp value to update its local clock) and to learn about the data rates supported by the other nodes.

Although necessary for the communication in ad hoc and multihop networks, beaconing uses scarce battery power for transmitting, receiving and processing of beacons and as well disturbs sleep cycles of nodes. Moreover, beacons may also interfere with regular data transmissions. Hence, data packets are destroyed and need to be retransmitted, consuming even more battery power, reducing the capacity in the network, and introducing additional delay. In addition, stations using power save mode will need to consume more power because they'll need to awaken more often, which reduces power saving mode benefits. A similar reasoning may also be performed for the used transmit power.

Summary of the Invention

Beaconing is very important in all ad hoc and multihop networks (especially for QoS routing) since the topology need to be well reflected in multihop networks for efficient operation. However, the amount of overhead that the transmissions of beacons generate can be substantial, the power consumed for the transmission degrading the battery lifetime and the radio resources taken up and the interference, added far from negligible.

The problem is to provide the desired precision of topology knowledge of an ad hoc or multihop network and at the same time limit the drawbacks of the beaconing stated above.

The object of the present invention is to provide a method, system and program that overcomes the drawbacks of the prior art techniques. This is achieved by the a method as defined in claims 1 and 12, the system as defined in claim 30, the radio node as defined in claim 23 and the program product as defined in claim 28.

In the method according to the present invention beacon messages (HELLO messages) are transmitted between a plurality of radio nodes in an ad hoc or multihop network. The rate of which the radio nodes transmit their beacons is based on an estimate of the network dynamics. Also the transmit power of the beacons are preferably based on an estimate of the network dynamics. The radio nodes bases their estimate of the network dynamics on beacons received from neighboring radio nodes.

The method according to the invention may comprises the following steps. The method should be performed in at least one radio node, but preferably as many radio nodes as possible in the network.

a) *-defining* a subset of neighbours; wherein the first radio node

b) *-recording and storing* beacon messages or beacon parameters relating to beacon messages from at least a second radio node which is part of the subset;

c) *-estimating* the network dynamics, based on the beacons received, or beacon parameters, from at least the second radio node in the subset;

d) *-determining* beacon transmission rate, based on the estimate of the network dynamics.

The method may also comprise a step of comparing estimates of network dynamics, wherein if the current estimate of network dynamics differ with at least a predetermined amount from a previous estimate of the network dynamics, the method proceeds to the determining step d), and otherwise the first the method continues to monitor the neighbouring radio nodes in the subset (steps a-c).

The system of a plurality of radio nodes according to the present invention is forms an ad hoc or multihop network, wherein the radio nodes transmits beacon messages (HELLO messages) between each other. The rate of which at least one of the radio nodes in the system transmit its beacons is based on an estimate of network dynamics.

The radio node according to the present invention is adapted to communicate with a plurality of other radio nodes in an ad hoc or multihop network, wherein the radio node transmits and receives beacon messages (HELLO messages) to and from at least one of the radio nodes of the plurality of radio nodes. The rate of which the radio node transmit its beacons is based on an estimate of network dynamics.

According to one embodiment of the present invention the radio node comprises a transmitting part and a receiving part, which comprises a transmitter and a receiver and thereto associated signal processing means, respectively. The receiving part is arranged to receive, store and process a plurality of beacon messages to determine an estimate of the networks dynamics, and in that the transmitting part is arranged to adjust the rate of which the radio node transmits beacons is based on the estimate of the network dynamics. This may preferably be implemented so that the receiving part comprises a beacon recording module for

recording a plurality of beacon messages, and determining beacon parameters. The beacon parameters comprising for example the respective received signal power and time of arrival of the received beacon messages. The receiving part further comprises a storing module for storing the beacon parameters, and a statistical processing module for performing the statistical analysis on the beacon parameters provided by the storing module. The transmitting part preferably comprises a beacon adjusting module for determining and adjusting the transmission rate and/or power of transmitted beacon messages based on the estimate of the network dynamics provided by the statistical processing module.

Thanks to the present invention it is possible to minimise the overhead related to beacon messages in an ad hoc or multihop network.

One advantage of the present invention is that the accuracy of the topology map is good, and connections are efficiently maintained when topology changes, e.g. caused by the mobility among the mobile radio nodes. This will improve the throughput for connections in the network. An efficient beacon protocol, such as provided by the method of the present invention, is especially important for multihop networks offering QoS (Quality of Service) with bandwidth (i.e. data rate) guarantees.

A further advantage is that method and arrangement according to the present invention will further significantly reduce the power consumption of the radio nodes, and at the same time assure that the accuracy of the topology map is good. This will improve battery lifetime of the mobile radio nodes.

Embodiments of the invention are defined in the dependent claims. Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings and claims.

Brief Description of the Drawings

The invention will now be described in detail with reference to the drawing figures, wherein

Fig. 1 is a schematic view over a plurality of ad hoc network and access points to fixed networks (Prior Art);

Fig. 2 is a schematic view over nodes forming an ad hoc network in which the method according to the present invention may be utilized;

Fig. 3 is a flowchart over the method according to the present invention;

Fig. 4 a-f illustrate different scenarios in a network that influence the estimate of the network dynamics in the method according to the present invention; and

Fig. 5 is a schematic illustration of a radio node according to the present invention.

Detailed Description of the invention

FIG. 2 is a schematic view illustrating an example of an ad hoc or multihop wireless communication network 200, in which the method and arrangement according to the present invention advantageously may be utilized. The network comprises a plurality of mobile radio nodes, 205:1, 205:2, …, 205:υ,…, 205:n. Preferably each mobile radio node 205 has the capability of acting as a router. Examples of mobile radio nodes include, but are not limited to mobile terminals (cellular phones), laptop computers and PDAs with wireless communication interfaces, and combination of such devices. Various radio transmissions techniques may be utilized, for example, time division multiple access (TDMA), spatial time division multiple access (STDMA), code division multiple access (CDMA), carrier sense multiple access (CSMA), or standards such as Bluetooth™ and WLAN. The network may also comprise devices (not shown) that has limited, or none, routing capability, which can communicate with other entities in the network, but not transfer messages. In addition the network may comprise fixed radio nodes 215, which preferably provides access points to other communication networks such as LANs, PLMNs (i.e. cellular systems) and PSTNs.

The mobile radio nodes 205 may move around, go into sleep-mode, leave the network, for e.g. by being turned off, and other radio nodes 205 may be added to the network. The scenario is then an ever changing communication network, wherein the rate of change and the magnitude of change may differ significantly for different networks and parts of networks, but also a particular network may have a different behaviour at different times, for example. The term *network dynamics*, which will be used hereinafter, is meant to characterize the dynamic properties of an ad hoc or multihop wireless communication network, and may be based on measures on rate of changes and magnitude of changes in the network.

The radio nodes 205, as previously described, maintain the network by repeated signalling with beacon (or HELLO) messages, which are needed to establish possible routing paths. The beacon messages typically represent a significant amount of overhead in the network and consume power.

In the method and arrangement according to the present invention the mobile radio nodes 205 and possibly also the fixed radio nodes 215 of the ad hoc or multihop wireless communication network 200, adapt the period in-between its transmitted the beacon messages and/or the transmission power used in transmitting the beacon massages, based on the networks dynamics. According to the inventive method radio nodes 205, 215 draws conclusions about network dynamics based on the incoming beacon messages from other radio nodes. Hence, the method may be seen as distributed to the individual radio nodes, as preferably each node make its own analysis and adaptation, based on the local topology of the network.

Considering the mobile radio node 205:v, a first embodiment of the method according to the invention comprises the following main steps, preferably to be executed in each radio node 205, 215, which steps are illustrated in the flowchart of FIG. 3.

305: Define a subset of neighbours.
It is often not feasible to take all radio nodes in the network under consideration. Therefore a subset of neighbouring radio nodes is defined for the mobile radio node 205:v. The subset, denoted NB_v, may comprise a predetermined number of the closest radio nodes, for example the ten closest neighbours. Alternatively radio nodes within a predetermined distance are comprised in the subset. Preferably, distances relates to the path loss of the radio signal of the

beacon message, but other form of measures of distances may be used, if such are available, e.g. by the use of GPS.

310: Record and store beacons.

The mobile radio node 205:υ record beacon messages from each of the neighbours in the subset NB_v and stores beacon parameters for the respective beacon messages. The beacon parameters may comprise received power, time of arrival, measures of distance or position of the sending node, for example. The parameters may be derived by the receiving radio node or alternatively, or in combination with, parameters that have been included by the sending radio node in the beacon message.

315: Estimate the network dynamics.

Based on the beacon parameters of the received beacon messages from the neighbours in the subset NB_v the mobile radio node 205:υ makes an estimate of the network dynamics as experienced by that radio node. A predetermined number of previously received beacons, or alternatively beacons received in a predetermined time period are considered. The estimate may take into account the magnitude of changes and the rate of changes in the subset of neighbours NB_v, preferably by measuring relative path loss i.e. a measure of the relative speed of the mobile radio node 205:υ, as compared to its neighbouring radio nodes. Hence, a mobile radio node in the subset NB_v that is close to the mobile radio node 205:υ, and moving with a certain speed, will have greater impact on the estimate of the network dynamics than another mobile radio node, moving with the same speed but at a greater distance from the mobile radio node 205:υ. In other words, changes in a local region of the mobile radio node 205:υ will be given higher weight than changes in a remote region, in the estimate of the network dynamics.

320: Compare estimates of network dynamics.

If the current estimate of network dynamics differs from the previous, or alternatively and preferably: differ with a predetermined amount, the algorithm proceeds with step 325. Otherwise, i.e. no or insignificant changes in the estimate, the mobile radio node 205:υ continues to monitor the neighbouring radio nodes to detect changes in the network dynamics, i.e. steps 305-320.

325: Determine beacon rate.

The mobile radio node 205:v determines a rate for the transmission of beacon messages based on the estimate of the network dynamics from step 315.

330: Transmit beacons.

The mobile radio node 205:v transmit beacon messages adapted to the network dynamics. The steps 305-320 are repeated to determine if the beacon transmit rate and/or transmit power should be updated.

As previously discussed the transmission power of the beacons may advantageously be adjusted based on the network dynamics, in the same manner as the beacon transmission rate. The method may then further comprise the additional step of:

327: Determine beacon transmission power.

The mobile radio node 205:v determines a transmission power for the beacon messages based on the estimate of the network dynamics from step 315.

In a second embodiment of the present invention the mobile radio node 205:v determines a beacon rate and possibly a transmit power for each beacon it will transmit. Steps 315-325 (327) will then be replaced by steps 315', and 330 by 330', according to:

315': Determine beacon rate and transmission power.

The mobile radio node 205:v determines the beacon rate and possibly transmit power for the next beacon based on the path loss history of the radio nodes in the subset NB_v.

330': Transmit beacons.

The mobile radio node 205:v transmit a beacon adapted to the network dynamics as determined in step 315'.

This alternative embodiment may be described in a more formalistic way in which the transmit power $P_{TX}^{i}(v)$ and the beacon rate $B_{rate}^{i}(v)$ for the i:th beacon of the mobile radio node 205:v may be calculated as a function of the path loss history:

$$P_{TX}^{i}(v) = f_1\left(G_{j_k}; j_k \in J_k, k \in NB_v\right), \tag{1}$$

$$B_{rate}^{i}(\nu)=f_2\left(G_{j_k};j_k\in J_k,k\in NB_\nu\right), \qquad (2)$$

wherein G_{j_k} is the path loss towards radio node k for the j:th beacon received from radio node k, J_k is the (possibly truncated) history of beacons received from radio node k, and NB_ν are the neighbours of node υ, and f_1 and f_2 are some arbitrary objective functions that regulate the transmit power and the beacon rate to some predetermined performance goals. The objective functions shall be interpreted in a broad sense in that it can involve simple linear processing of input parameters or more advanced processing involving various mathematical tools such as transforms, iterations, etc. As can be deduced from the above formulation, the neighbour with the highest relative speed in respect to the centre of gravity of the nodes will have the most impact on the transmit power and beacon rate. The path loss (or path gain) may preferably be determined by that the beacons indicate the power levels used in the header of the beacon message. Based on receive power level and knowledge on transmitted level, the (open loop) path gain is easily determined. Other methods (e.g. closed loop approaches) for path loss determination may also be used. The transmit power $P_{TX}^{i}(\nu)$ and the beacon rate $B_{rate}^{i}(\nu)$ for the i:th beacon of the mobile radio node 205:υ can, apart from using relation (1) and (2), possibly also be determined from a single objective function that is optimized by searching the definition space of $P_{TX}^{i}(\nu)$ $B_{rate}^{i}(\nu)$.

The impact on the estimate of network dynamics from the neighbours with respect to their relative speed may be visualised as in FIG. 4 a-f. Depicted in FIG. 4a the mobile radio node 205:υ is in a stationary situation with the mobile radio node 205:1. The two mobile radio nodes are probably both stationary, but a stationary situation may also occur if the two radio nodes are moving with essentially the same velocity. In FIG. 4b the beacons from the mobile radio node 205:1 as received by the mobile radio node 205:υ is graphically illustrated as received signal strength vs. time. This can also be seen as an illustration of the history of beacons J_k (k=1). As seen in the graph, the beacons from the mobile radio node 205:1 are received with essentially constant strength, apart from some variations due to variations in time of the radio channel. In FIG. 4 c and d, a mobile radio node 205:2 is moving at a speed v at a fairly large distance from the mobile radio node 205:υ. As the relative speed between the mobile radio nodes 205:υ and 205:2 will be small if the distance between them is large the

changes over time in the received signal strength of the beacons transmitted by the mobile radio node 205:1 and received by the mobile radio node 205:υ will be moderate, which is seen in FIG. 4d. If on another hand a mobile radio node 205:3 is close to the mobile radio node 205:υ, as shown in FIG. 4e, and moves with the same speed v, for example, the relative speed between the mobile radio nodes 205:υ and 205:2 will be large. This will be reflected in the history of the beacons as illustrated in the graph of FIG. 4f, wherein significant changes in the received signal strength is seen.

The history of the beacons as received by the mobile radio node 205:υ may be analysed with known methods, for example simple measures as relative differences between consecutive beacons, changes in the derivative of the received signal strength or with more elaborate statistical methods.

In the above scenario the mobile radio node 205:3 will have the greatest impact on the network dynamics as experienced by the mobile radio node 205:υ, which will have to adapt its beacon transmission rate to that radio node, typically a relatively high rate. If the mobile radio node 205:3 were not present, an almost stationary network would be seen by the mobile radio node 205:υ and hence a lower rate could be used. The beacon transmission power will typically be governed mostly by the more remote neighbour, rather than a close neighbour with high relative speed. However, the history of the beacons can be used to for example predict that a fast moving mobile radio node soon will need a high transmission power, as will be further discussed below.

For simplicity the beacon rates has in FIG. 4 b, d and f been illustrated as equal and constant. If the method according to the invention is utilised by the radio nodes in the network, the beacon rate is a variable parameter. This does not necessarily limit the analysis of the received beacons. In fact, since the rate of which a radio node transmit its beacons is a reflection of how that radio node experience the network, by another radio node received beacon rate can be incorporated in the estimate of the network dynamics. Note that in a region with high relative mobility the beacon rates will be high to reflect changes in the actual topology, whereas in other regions where the relative mobility is lower the rates will be low as there are no or few significant changes in the network topology.

From the estimates of the network dynamics it is, in the exemplified embodiments of the invention, possible to draw conclusions about the networks future behaviour and hence, appropriate future beacon rates and transmission powers. These types of conclusions can be made thanks to that the histories of the received beacons from each radio node are analysed. From this conclusions on for example relative velocity of the mobile radio nodes can be made. A predictor may use this knowledge, possibly in combination with a priori knowledge or acquired knowledge, to estimate beacon rates and transmission powers for a future period of time. Suitable predictors are known in the art and could for instance be base on exponential smoothing or some sort of filter, depending on the needed accuracy. In a third embodiment of the invention a predicting functionality is included in the steps wherein the beacon rates and transmission powers are determined, corresponding to steps 325, 327 and 315' in the first and second embodiment, respectively.

The method according to the present invention may be implemented in various ways. A fourth embodiment of the invention exemplifies a possible implementation. In this embodiment of the invention, the transmit power and beacon rate are based on the previous transmit power and beacon rate and the absolute value of the relative difference in path loss $\left|\Delta G_{j_k}\right|$, i.e.:

$$\Delta G_{j_k} = \left|\frac{G_{j_k} - G_{j_k-1}}{G_{j_k-1}}\right| \qquad (3)$$

and hence the transmit power and beacon rate is calculated as:

$$P_{TX}^{i}(\nu) = f_1\left(P_{TX}^{i-1}(\nu), G_{j_k}, \Delta G_{j_k}; i \in I, j_k \in J_k, k \in NB_\nu\right) \qquad (4)$$

$$B_{rate}^{i}(\nu) = f_2\left(B_{rate}^{i-1}(\nu), G_{j_k}, \Delta G_{j_k}; i \in I, j_k \in J_k, k \in NB_\nu\right) \qquad (5)$$

wherein I is the (possibly truncated) history of beacons transmitted by the mobile radio node 205:ν. The embodiment is convenient and efficient in that the history of the beacons are "reused" as the relative difference ΔG_{j_k} is considered.

The present invention makes it possible to minimise the overhead related to beacon messages in an ad hoc or multihop network. The accuracy of the topology map is good, and connections

are efficiently maintained when topology changes, e.g. caused by the mobility among the mobile radio nodes. This will improve the throughput for connections in the network. An efficient beacon protocol, such as provided by the method of the present invention, is especially important for multihop networks offering QoS (Quality of Service) with bandwidth (i.e. data rate) guarantees.

A radio node (205) adapted for utilizing the method according to the present invention is schematically illustrated in FIG. 5. The radio node according to the present invention comprises a transmitting part 501 and a receiving part 502, which comprises a transmitter and a receiver and thereto associated signal processing means, respectively. The receiving part is arranged to receive, store and process a plurality of beacon messages to determine an estimate of the networks dynamics, and in that the transmitting part is arranged to adjust the rate of which the radio node transmits beacons is based on the estimate of the network dynamics. This may preferably be implemented so that the receiving part 502 comprises a beacon recording module 505 for recording a plurality of beacon messages (step 310), and determining beacon parameters, the beacon parameters comprising for example the respective received signal power and time of arrival of the received beacon messages, a storing module 510 for storing the beacon parameters, and a statistical processing module 515 for performing the statistical analysis (steps 315, 320) on the beacon parameters provided by the storing module 510.

The transmitting part 501 preferably comprises a beacon adjusting module (520) for determining and adjusting the transmission rate and/or power of transmitted beacon messages (step 325, 327 and 330), based on the estimate of the network dynamics provided by the statistical processing module.

The above described implementation should be regarded as a non limiting example. As apparent to the skilled in the art the above "modules" should be regarded as functional units, and not necessarily physical entities, and comprising in this sense has the meaning of functionally linked modules.

The method and arrangement will further significantly reduce the power consumption of the radio nodes, and at the same time assure that the accuracy of the topology map is good. This will improve battery lifetime of the mobile radio nodes 205.

The method according to the present invention is preferably implemented by means of program products or program module products comprising the software code means for performing the steps of the method. The program products are preferably executed on a plurality of radio nodes 205, 215 within an ad hoc or multihop network. The program is distributed and loaded from a computer usable medium, such as a floppy disc, a CD, transmitted over the Internet etc.

While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not to be limited to the disclosed embodiments, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

NEW CLAIMS FOREIGN FILING!

CLAIMS:

1. A method of transmitting beacon messages between a plurality of radio nodes (205, 215) in an ad hoc or multihop network **characterised in** that the rate of which a first radio node transmits its beacons is based on an estimate of the network dynamics.

2. Beacon transmitting method according to claim 1, **further comprising** that the beacon transmit power at which the first radio node radio transmits its beacons is based on an estimate of the network dynamics.

3. Beacon transmitting method according to claims 1 or 2, **wherein** the estimate of the network dynamics is performed at least by the first radio node and based on a plurality of beacons received from at least a second radio node by the first radio node.

4. Beacon transmitting method according to claim 3, **wherein** the estimate of the network dynamics is based on analysis of the relative speed of the at least the second radio node compared to the first radio node.

5. Beacon transmitting method according to claim 4, **wherein** the estimate of the network dynamics is based on analysis of the relative speed of a plurality of neighbouring radio node and wherein the neighbouring radio node that exhibit the highest relative speed compared to the first radio node, is given the greatest impact on the estimate of the network dynamics.

6. Beacon transmitting method according to any of claims 1 to 5, **wherein** at least the first radio node performs the steps of:
a) -*defining* a subset, NB_v, of neighbours (305);
b) -*recording* beacon message (310) from at least a second radio node which is part of the subset and *storing* beacon parameters of the respective beacon messages;
c) -*estimating* the network dynamics (315), based on the beacon parameters of the beacon messages received from at least the second radio node in the subset;
d) -*determining* beacon rate (325), based on the estimate of the network dynamics.

7. Beacon transmitting method according to claim 6, **wherein** the method comprises a step, to be performed prior to the determining step d), of:
-comparing estimates of network dynamics (320), wherein if the current estimate of network dynamics differ with at least a predetermined amount from a previous

estimate of the network dynamics, the method proceeds to the determining step d), and otherwise the first the method continues to monitor the neighbouring radio nodes in the subset (steps a-c).

8. Beacon transmitting method according to claim 6, **wherein** the step of estimating the network dynamics, the estimate of the network dynamics is at least partly based on the path loss history of the beacons received from at least the second radio node in the subset.

9. Beacon transmitting method according to claim 6, **wherein** the beacon parameters comprise at least one parameter relating to received signal strength of the beacon message, and at least one parameter relating to time of arrival of the beacon messages.

10. Beacon transmitting method according to claim 9, **wherein**, the beacon parameters comprise parameters that have been included by the sending radio node in the beacon message.

11. Beacon transmitting method according to claim 10, **wherein**, at least one parameter originally included by the sending radio node comprises a parameters relating to the position of the sending node.

12. A method in a radio node (205) of transmitting beacon messages to at least a second radio node in an ad hoc or multihop network, wherein the ad hoc or multihop network comprises a plurality of radio nodes (205, 215), the method in the first radio node **characterised in** that the rate of which the first radio node transmits its beacons is based on an estimate of the network dynamics.

13. Beacon transmitting method according to claim 12, **wherein** the beacon transmit power at which the first radio node radio transmits its beacons is based on an estimate of the network dynamics.

14. Beacon transmitting method according to claims 12 or 13, **wherein** the estimate of the network dynamics is performed by the first radio node and based on a plurality of beacons received from at least a second radio node.

15. Beacon transmitting method according to claim 14, **wherein** the estimate of the network dynamics is based on analysis of the relative speed of the at least the second radio node compared to the first radio node.

16. Beacon transmitting method according to claim 15, **wherein** the estimate of the network dynamics is based on analysis of the relative speed of a plurality of neighbouring radio nodes and wherein the neighbouring radio node that exhibit the highest relative speed compared to the first radio node, is given the greatest impact on the estimate of the network dynamics.

17. Beacon transmitting method according to any of claims 12 to 17, **wherein** the first radio node performs the steps of:
a) -*defining* a subset, NB_v, of neighbours (305);
b) -*recording* beacon message (310) from at least a second radio node which is part of the subset and *storing* beacon parameters of the respective beacon messages;
c) -*estimating* the network dynamics (315), based on the beacon parameters of the beacon messages received from at least the second radio node in the subset;
d) -*determining* beacon rate (325), based on the estimate of the network dynamics.

18. Beacon transmitting method according to claim 17, **wherein** the method comprises a step, to be performed prior to the determining step d), of:
-comparing estimates of network dynamics (320), wherein if the current estimate of network dynamics differ with at least a predetermined amount from a previous estimate of the network dynamics, the method proceeds to the determining step d), and otherwise the first the method continues to monitor the neighbouring radio nodes in the subset (steps a-c).

19. Beacon transmitting method according to claim 18, **wherein** the step of estimating the network dynamics, the estimate of the network dynamics is at least partly based on the path loss history of the beacons received from at least the second radio node in the subset.

20. Beacon transmitting method according to claim 17, **wherein** the beacon parameters comprise at least one parameter relating to received signal strength of the beacon message, and at least one parameter relating to time of arrival of the beacon messages.

21. Beacon transmitting method according to claim 20, **wherein**, the beacon parameters comprise parameters that have been included by the sending radio node in the beacon message.

22. Beacon transmitting method according to claim 21, **wherein**, at least one parameter originally included by the sending radio node comprises a parameters relating to the position of the sending node.

23. A radio node (205) adapted for communication in an ad hoc or multihop network, the radio node comprising and a transmitting part adapted to transmit beacon messages and a receiving part adapted to receive beacon messages, the radio node **characterized in** that the receiving part is arranged to receive, store and process a plurality of beacon messages to determine an estimate of the networks dynamics, and in that the transmitting part is arranged to adjust the rate of which the radio node transmits beacons is based on the estimate of the network dynamics.

24. Radio node according to claim 23, **wherein** the receiving part comprises:
-beacon recording means (505) for recording a plurality of beacon messages, and determining beacon parameters, the received beacon parameters comprising at least the respective received signal power and time of arrival of the received beacon messages;
-storing means (510) for storing the received beacon parameters;
-statistical processing means (515) for performing a statistical analysis on the stored plurality of beacon parameters, whereby producing an estimate of the network dynamics,
and wherein the transmitting part comprises:
-beacon adjusting means (520) for adjusting the transmission rate and/or power of transmitted beacon messages.

25. Radio node according to claim 24, **wherein** the statistical processing means (515) estimates the network dynamics at least partly based on analysis of the relative speed of the at least one other radio node compared to the first radio node.

26. Radio node according to claim 25, **wherein** the statistical processing means (515) estimates the network dynamics at least partly based on analysis of the relative speed of a plurality of neighbouring radio nodes and wherein the neighbouring radio node

that exhibit the highest relative speed compared to the first radio node, is given the greatest impact on the estimate of the network dynamics.

27. Radio node according to any of claims 23 to 26, **wherein** the beacon receiving means (505) is adapted to define a subset, NB_{ν}, of neighbouring radio nodes, and the storing means (510) is adapted to record and store received beacon parameters from at least a second radio node which is part of the subset.

28. Computer program products directly loadable into the internal memory of a processing means within a radio node (205, 215), comprising the software code means adapted for controlling the steps of any of the claims 12 to 22.

29. Computer program products stored on a computer usable medium, comprising readable program adapted for causing a processing means in a processing unit within at least the first radio node (205, 215), to control an execution of the steps of any of the claims 12 to 22.

30. A system of a plurality of radio nodes (205, 215) adapted to communicate in an ad hoc or multihop network, wherein the radio nodes (205, 215) transmits beacon messages (HELLO messages) between each other, the system **characterised in** that the radio nodes (205, 215) of the system uses the beacon transmitting method according to any of the claims 1 to 11.

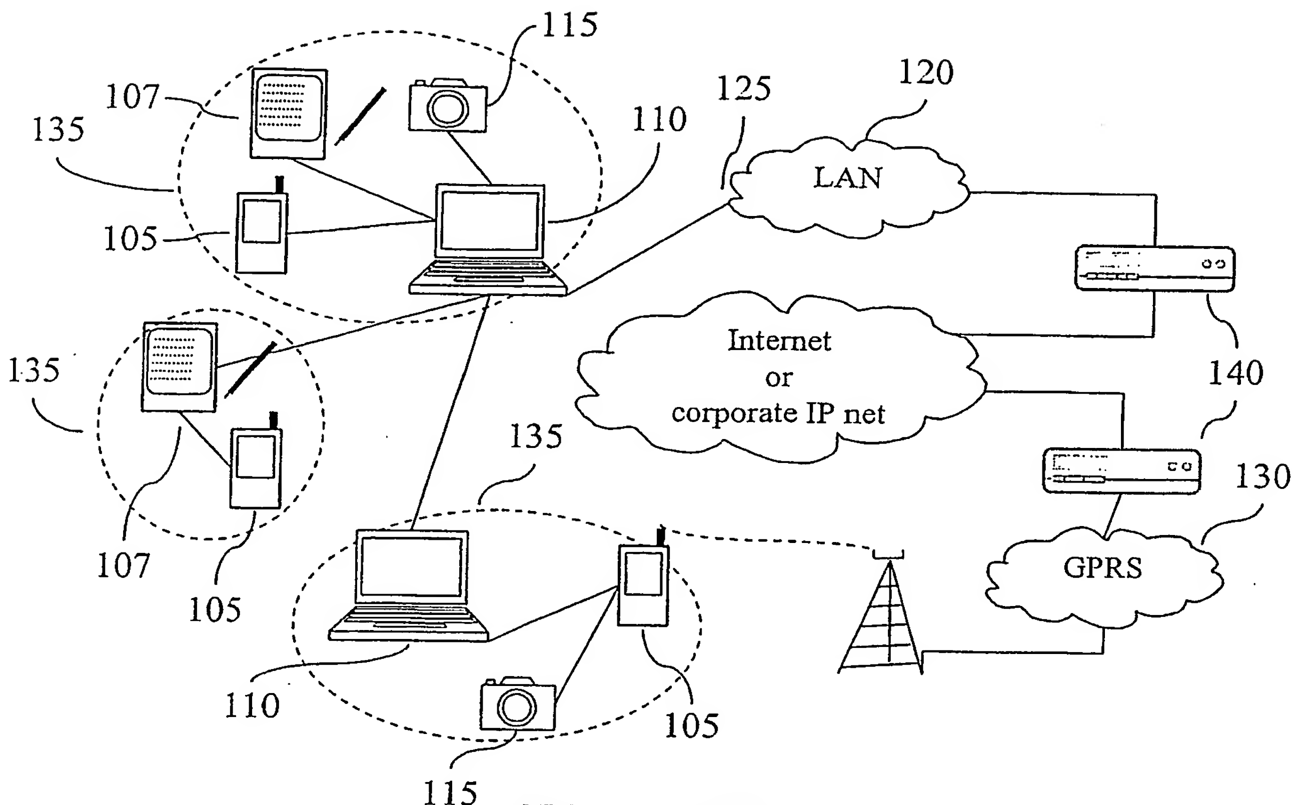


Fig. 1 (Prior Art)

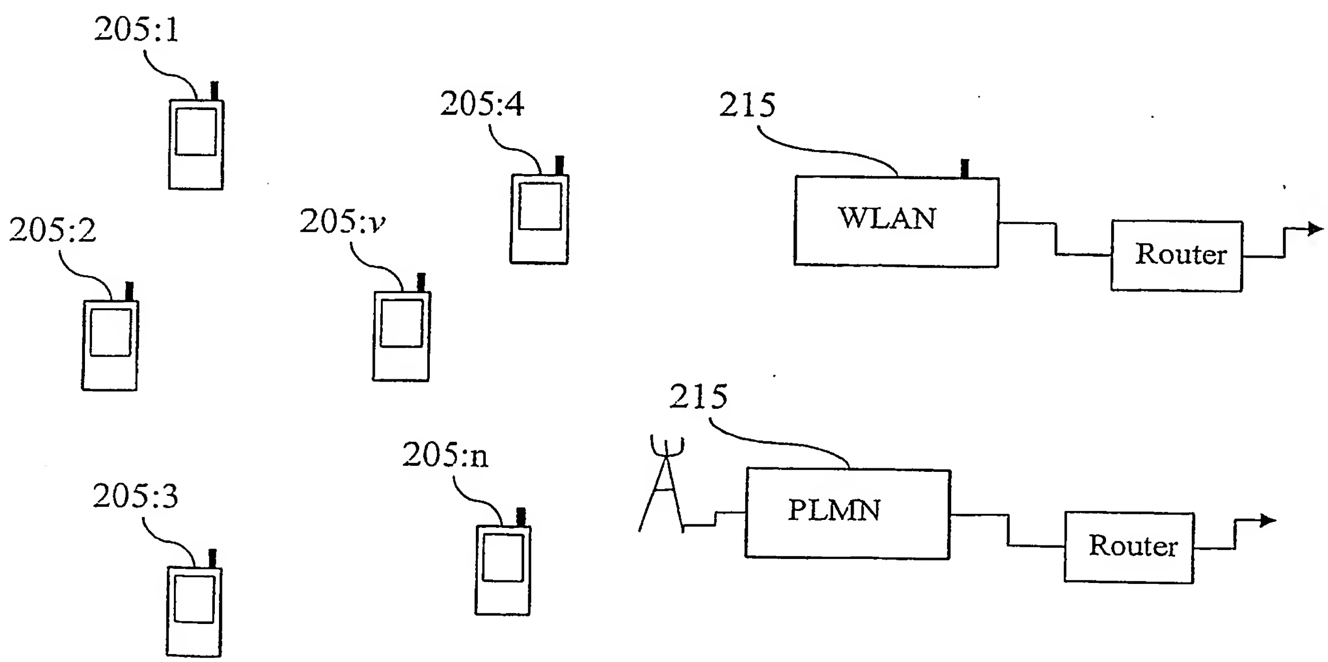


Fig. 2

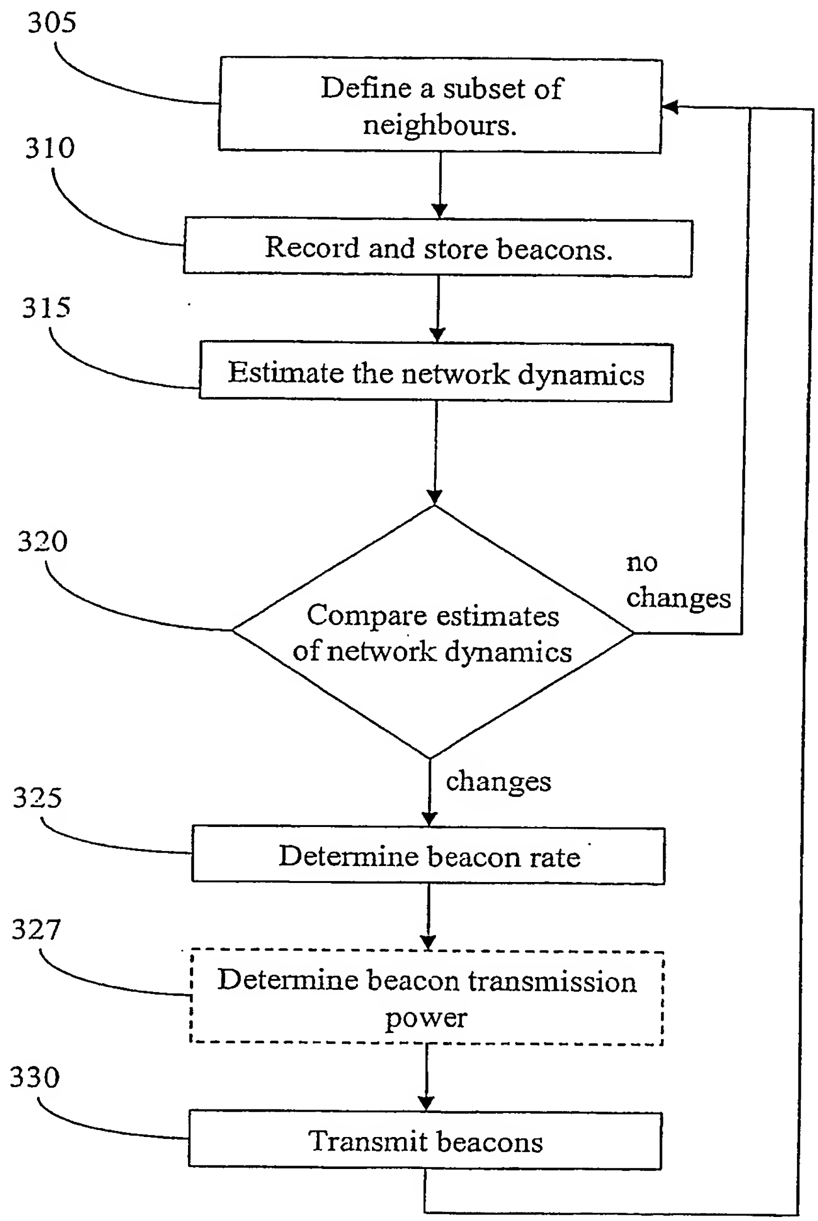

305
Define a subset of neighbours.
310
Record and store beacons.
315
Estimate the network dynamics
320
Compare estimates of network dynamics
no changes
changes
325
Determine beacon rate
327
Determine beacon transmission power
330
Transmit beacons

Fig. 3

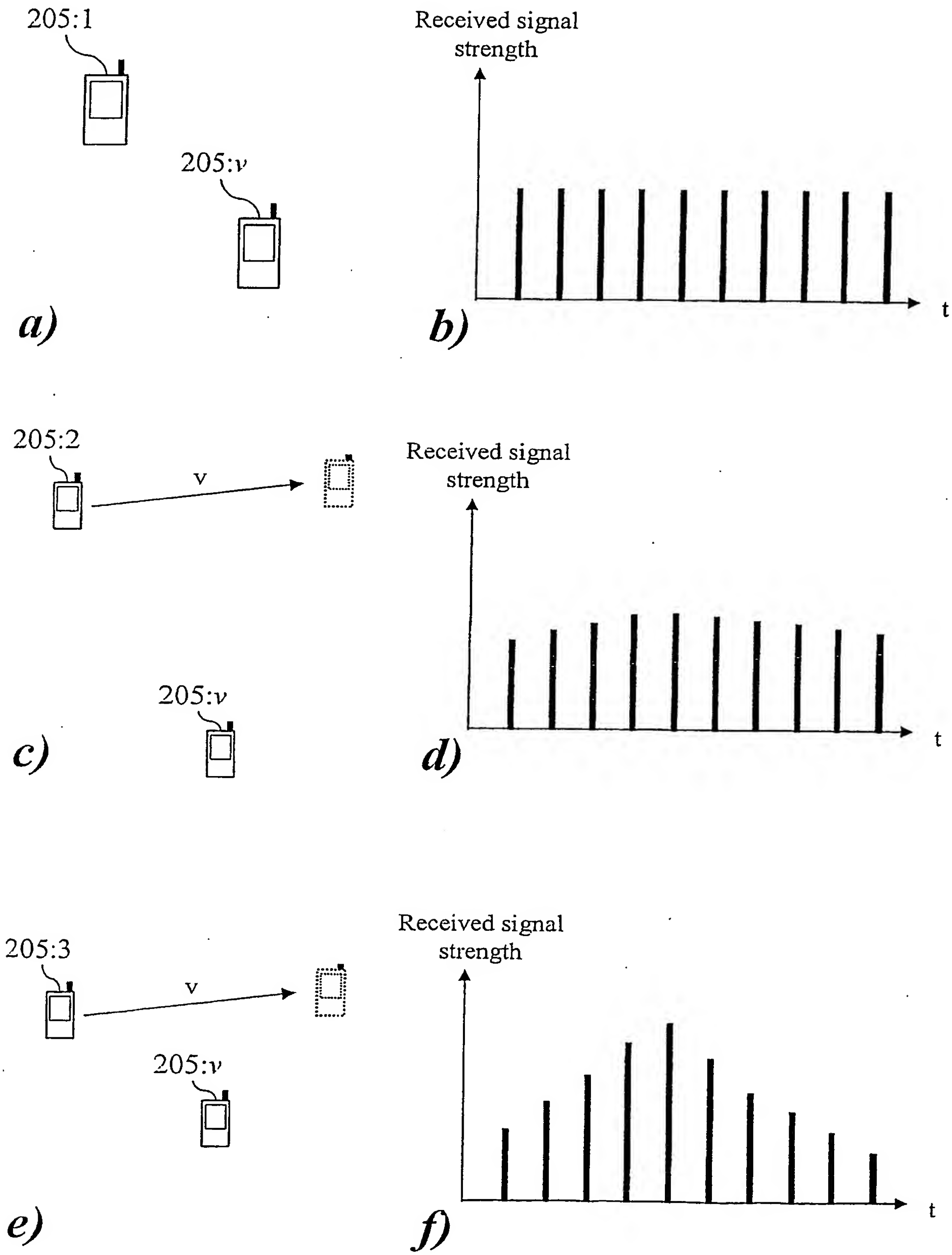

205:1
205:v
Received signal strength
t
a)
b)
205:2
v
205:v
Received signal strength
t
c)
d)
205:3
v
205:v
Received signal strength
t
e)
f)

Fig. 4

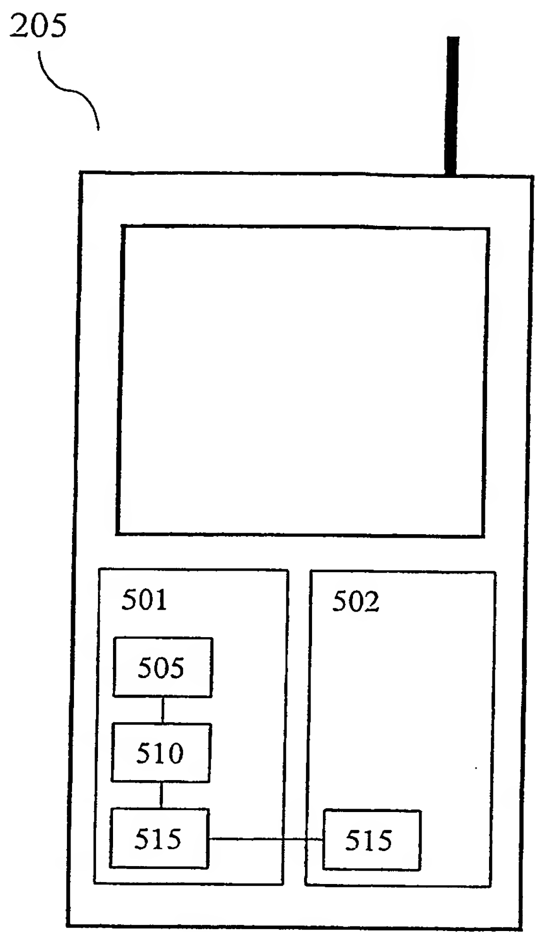


Fig. 5

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P06477PC00	**FOR FURTHER ACTION** See Form PCT/IPEA/416	
International application No. PCT/EP2004/014668	International filing date *(day/month/year)* 23.12.2004	Priority date *(day/month/year)* 30.12.2003
International Patent Classification (IPC) or national classification and IPC H04L12/56		
Applicant TELEFONAKTIEBOLAGET LM ERICSSON (PUBL) et al		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 4 sheets, as follows:
      - ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement.
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

Date of submission of the demand 28.10.2005	Date of completion of this report 05.12.2005
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Müller, N Telephone No. +49 89 2399-7144

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-15	as originally filed
4b	filed with the demand

Claims, Numbers

1-14	filed with the demand

Drawings, Sheets

1/4-4/4	as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☒ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☒ the claims, Nos. 15-30
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-14
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-14
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-14
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

The present invention relates to a method (**claim 1**) for adjusting the beacon rate in an ad hoc or multihop network, and the corresponding radio node (**claim 10**) and system (**claim 14**).

According to document **D1 = WO 01/92992**, which represents the closest prior art, an ad hoc radio node adjusts its beacon rate based on network dynamics in order to permit other nodes in the network to detect the node more quickly if the network changes fast (eg. when the node moves fast). However, according to D1, the network dynamics, ie. the movement of the node, is detected based on either the internal measurement of the node's physical speed or changes in the wireless connectivity with nearby neighbour nodes.

These two prior art solutions for determining the network dynamics have the following drawbacks: either the node has to be supplied with a speed determination equipment, or the node has to maintain a database of wireless connectivity with nearby neighbour nodes. Therefore, the problem to be solved by the present invention is to decrease the complexity of the node when determining the network dynamics.

According to the present invention, the node receives the beacons transmitted from other nodes. From said beacons, the node determines the **relative speed** of each other node relative to itself. The network dynamics are determined based on said determined relative speed values. Thereby, the node may adjust its beacon rate only by receiving and processing other beacon messages.

Claim 1 is therefore novel and considered to involve the required inventive step, Articles 33 (2) (3) PCT. The subject-matter of claim 1 is also industrially applicable.

The same applies to **independent claims 10 and 14**, which contain the same feature combination as claim 1 in terms of claims relating to a radio node and a system. Said claims, therefore, equally meet all the requirements of Article 33 PCT.

Dependent claims 2 to 9 and 11 to 13 relate to further implementing details of the method defined by claim 1, or the node of claim 10, respectively, to which they refer and are thus equally novel, inventive and industrially applicable.

Further Remarks

The feature "the relative speed of the radio nodes in the subset" in **claim 1** and "relative speed of each of the other nodes" in **claim 10** is not clear (Article 6 PCT) for the reason that in the description (see page 9, lines 16 to 17) and claim 11 the relative speed of the (neighbour) node is a relative speed of the (neighbour) radio node **compared to the first radio node.** It is noted that the feature "the relative speed of the radio nodes", as used in present claim 1, could be misinterpreted as "relative speed between (neighbour) radio nodes", which has no support in the original application documents.

Furthermore, it is clear from the description (see in particular page 4, lines 25 to 26) that the feature "adjusting the beacon rate **based on the estimate of the network dynamics**" is essential to the definition of the invention. Since **independent claim 10** does not contain said feature, said claim does not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention.

The expression "the radio nodes of the system **uses the beacon transmitting method** according to any of the claims 1 to 9" used in **independent claim 14** is vague and unclear, because it does not express that the concerned radio nodes *"comprise means being adapted/arranged to perform the method steps of any of claims 1 to 9"* but only that they are able, when being programmed or otherwise modified, to perform said method steps. Hence, said claim does not meet the requirements of Article 6 PCT.

The feature "...**the** first radio node ..." in **claim 11** is not clear, see Article 6 PCT, since said feature has not been previously defined in said claim or in any claim on which said claim depends, ie. there is no antecedent for said feature.

The vague and imprecise statement in the description on page 15, line 10 ("...**spirit and scope**...") implies that the subject-matter for which protection is sought may be different to

that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them.

CLAIMS:

1. A method in a radio node (205), the first radio node, of transmitting beacon messages to at least a second radio node in an ad hoc or multihop network, wherein the ad hoc or multihop network comprises a plurality of further radio nodes (205, 215), wherein the rate of which the radio node transmits its beacons is adaptive, the method in the first radio node **characterised by** the steps of
a) -*defining* a subset, NB_v, of neighbours (305);
b) -*recording* a plurality of beacon message (310) from the radio nodes which are part of the subset, and determining the relative speed of the radio nodes in the subset from the recorded respective plurality of beacon messages;
c) -*estimating* the network dynamics (315), based on the relative speed of the radio nodes in the subset;
d) -*determining* beacon rate (325), based on the estimate of the network dynamics.

2. Beacon transmitting method according to claim 1, **wherein** the beacon transmit power at which the first radio node radio transmits its beacons is based on the estimate of the network dynamics.

3. Beacon transmitting method according to claim 1or 2, **wherein** the estimate of the network dynamics is based on analysis of the relative speed of a plurality of neighbouring radio nodes and wherein the neighbouring radio node that exhibit the highest relative speed compared to the first radio node, is given the greatest impact on the estimate of the network dynamics.

4. Beacon transmitting method according to any of claims 1 to 3, **wherein** the method comprises a step, to be performed prior to the determining step d), of:
-comparing estimates of network dynamics (320), wherein if the current estimate of network dynamics differ with at least a predetermined amount from a previous estimate of the network dynamics, the method proceeds to the determining step d), and otherwise the first the method continues to monitor the neighbouring radio nodes in the subset (steps a-c).

5. Beacon transmitting method according to any of claims 1 to 4, **wherein** the step of estimating the network dynamics, the estimate of the network dynamics is at least partly based on the path loss history of the beacons received from the radio nodes in the subset.

6. Beacon transmitting method according to any of claims 1 to 5, **further comprising** a step of *storing* beacon parameters of the respective beacon messages.

7. Beacon transmitting method according to claim 7, **wherein** the beacon parameters comprise at least one parameter relating to received signal strength of the beacon message, and at least one parameter relating to time of arrival of the beacon messages.

8. Beacon transmitting method according to claim 6 or 7, **wherein,** the beacon parameters comprise parameters that have been included by the sending radio node in the beacon message.

9. Beacon transmitting method according to claim 8, **wherein,** at least one parameter originally included by the sending radio node comprises a parameters relating to the position of the sending node.

10. A radio node (205) adapted for communication in an ad hoc or multihop network, the radio node comprising and a transmitting part adapted to transmit beacon messages and a receiving part adapted to receive beacon messages, the radio node **characterized by**
-beacon recording means (505) for recording a plurality of beacon messages from a plurality of other radio nodes, and determining beacon parameters, the received beacon parameters comprising at least the respective received signal power and time of arrival of the received beacon messages;
-storing means (510) for storing the received beacon parameters;
-statistical processing means (515) for performing a statistical analysis on the stored plurality of beacon parameters, whereby producing an estimate of the network dynamics based on relative speed of each of the other radio nodes;
-beacon adjusting means (520) for adjusting the transmission rate and/or power of transmitted beacon messages.

11. Radio node according to claim 10, **wherein** the statistical processing means (515) estimates the network dynamics at least partly based on analysis of the relative speed of the at least one other radio node compared to the first radio node.

12. Radio node according to claim 11, **wherein** the statistical processing means (515) estimates the network dynamics at least partly based on analysis of the relative speed

of a plurality of neighbouring radio nodes and wherein the neighbouring radio node that exhibit the highest relative speed compared to the first radio node, is given the greatest impact on the estimate of the network dynamics.

13. Radio node according to any of claims 10 to 12, **wherein** the beacon receiving means (505) is adapted to define a subset, NB_v, of neighbouring radio nodes, and the storing means (510) is adapted to record and store received beacon parameters from at least a second radio node which is part of the subset.

14. ~~A system of a plurality of radio nodes~~ (205, 215) adapted to communicate in an ad hoc or multihop network, wherein the radio nodes (205, 215) transmits beacon messages (HELLO messages) between each other, the system **characterised in** that the radio nodes (205, 215) of the system uses the beacon transmitting method according to any of the claims 1 to 9.

WO 01/92992 and WO 01/73959 teach methods of a radio node, or router, transmitting beacon messages to other radio nodes in a network. The rate of which the node/router transmits its beacons is adaptive. The rate is determined from for example physical speed, the change in wireless connectivity with nearby neighbour nodes or expected plans for further movement. The rate may further be influenced by the start up conditions of the node/router. The physical speed, which only referrers to the speed of node/router in question, can be determined from for example positioning tools or by monitoring the rate of change of nearby nodes over time.

INTERNATIONAL SEARCH REPORT

PCT/EP2004/014668

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04L12/56

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 01/92992 A (BBNT SOLUTIONS LLC) 6 December 2001 (2001-12-06)	1,3,4,6, 12,14, 15,17, 23,27-30
Y	page 2, line 18 - line 23 page 3, line 24 - line 30 page 6, line 17 - page 7, line 2 page 11, line 11 - page 12, line 20 page 13, line 29 - page 15, line 2 figures 6,8 -----	2,7,8, 13,18,19
X	WO 01/73959 A (GTE SERVICE CORPORATION) 4 October 2001 (2001-10-04)	1,12, 28-30
Y	page 7, line 24 - page 11, line 19 figures 3,4 -----	7,8,18, 19

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 April 2005	03/05/2005

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Müller, N

INTERNATIONAL SEARCH REPORT

PCT/EP2004/014668

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2002/044533 A1 (BAHL PARAMVIR ET AL) 18 April 2002 (2002-04-18)	2,13
A	page 1, paragraph 10	1,12,23, 28-30
	page 2, paragraph 32	
P,X	WO 2004/023241 A (HARRIS CORPORATION) 18 March 2004 (2004-03-18) page 3, line 16 - page 4, line 34	1,12, 28-30
E	EP 1 511 234 A (HITACHI, LTD) 2 March 2005 (2005-03-02)	1,3,6, 12,14, 17,23, 27-30
	column 2, paragraph 7 - column 4, paragraph 14	

INTERNATIONAL SEARCH REPORT

PCT/EP2004/014668

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
WO 0192992	A	06-12-2001	AU	6349801	A	11-12-2001
			WO	0192992	A2	06-12-2001
			US	2003128690	A1	10-07-2003
WO 0173959	A	04-10-2001	US	6512935	B1	28-01-2003
			AU	4946201	A	08-10-2001
			WO	0173959	A1	04-10-2001
US 2002044533	A1	18-04-2002	NONE			
WO 2004023241	A	18-03-2004	US	2004042417	A1	04-03-2004
			AU	2003268176	A1	29-03-2004
			WO	2004023241	A2	18-03-2004
EP 1511234	A	02-03-2005	EP	1511234	A1	02-03-2005

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

LARSSON et al Atty. Ref.: **4208-51**

Serial No. **to be assigned** Group: **unknown**

National Phase of: **PCT/EP2004/014668**
International Filing Date: **23 December 2004**

Filed: **February 9, 2007** Examiner: **Unknown**

For: **METHOD AND ARRANGEMENT IN WIRELESS AD HOC OR MULTIHOP NETWORKS**

* * * * * * * * * * *

February 9, 2007

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

PRELIMINARY AMENDMENT

Prior to calculation of the filing fee and in order to place the above identified application in better condition for examination, please amend as follows:

AMENDMENTS TO THE ABSTRACT

Please insert the Abstract of the Disclosure which is on the attached sheet.

AMENDMENTS TO THE SPECIFICATION

Page 1, after the title insert the following:

This application is the US national phase of international application **PCT/EP2004/014668**, filed **23 December 2004**, which designated the U.S. and claims priority of **SE 0303584-7**, filed **30 December 2003**, and EP 04015198.7, filed 29 June 2004, the entire contents of each of which are hereby incorporated by reference.

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application: **(AS ON AMENDED SHEET(S) ANNEXED TO IPRP)**

15. (new) A method in a radio node, the first radio node, of transmitting beacon messages to at least a second radio node in an ad hoc or multihop network, wherein the ad hoc or multihop network comprises a plurality of further radio nodes, wherein the rate of which the radio node transmits its beacons is adaptive, wherein the method in the first radio node comprises the steps of

a) -*defining* a subset, NB_v, of neighbours;

b) -*recording* a plurality of beacon message from the radio nodes which are part of the subset, and determining the relative speed as compared to the first radio node of the radio nodes in the subset from the recorded respective plurality of beacon messages;

c) -*estimating* the network dynamics, based on the relative speed of the radio nodes in the subset;

d) -*determining* beacon rate, based on the estimate of the network dynamics.

16. (new) Beacon transmitting method according to claim 15, wherein the estimate of the network dynamics is based on analysis of the relative speed as compared to the first radio node of a plurality of neighbouring radio nodes and wherein the neighbouring radio node that exhibit the highest relative speed compared to the first radio node, is given the greatest impact on the estimate of the network dynamics.

17. (new) Beacon transmitting method according to claim 16, wherein the method comprises a step, to be performed prior to the determining step d), of:
-comparing estimates of network dynamics, wherein if the current estimate of

network dynamics differ with at least a predetermined amount from a previous estimate of the network dynamics, the method proceeds to the determining step d), and otherwise the first the method continues to monitor the neighbouring radio nodes in the subset (steps a-c).

18. (new) Beacon transmitting method according to claim 17, wherein the step of estimating the network dynamics, the estimate of the network dynamics is further at least partly based on the path loss history of the beacons received from the radio nodes in the subset.

19. (new) Beacon transmitting method according to of claim 18, further comprising a step of *storing* beacon parameters of the respective beacon messages.

20. (new) Beacon transmitting method according to claim 19, wherein the beacon parameters comprise at least one parameter relating to received signal strength of the beacon message, and at least one parameter relating to time of arrival of the beacon messages.

21. (new) Beacon transmitting method according to claim 20, wherein, the beacon parameters comprise parameters that have been included by the sending radio node in the beacon message.

22. (new) Beacon transmitting method according to claim 32, wherein at least one parameter originally included by the sending radio node comprises a parameters relating to the position of the sending node.

23. (new) Beacon transmitting method according to claim 15, wherein the beacon transmit power at which the first radio node radio transmits its beacons is based on the estimate of the network dynamics.

24. (new) Beacon transmitting method according to claim 23, wherein the estimate of the network dynamics is based on analysis of the relative speed as compared to the first radio node of a plurality of neighbouring radio nodes and wherein the neighbouring radio node that exhibit the highest relative speed compared to the first radio node, is given the greatest impact on the estimate of the network dynamics.

25. (new) Beacon transmitting method according to claim 24, wherein the method comprises a step, to be performed prior to the determining step d), of:
-comparing estimates of network dynamics, wherein if the current estimate of network dynamics differ with at least a predetermined amount from a previous estimate of the network dynamics, the method proceeds to the determining step d), and otherwise the first the method continues to monitor the neighbouring radio nodes in the subset (steps a-c).

26. (new) Beacon transmitting method according to claim 25, wherein the step of estimating the network dynamics, the estimate of the network dynamics is further at least partly based on the path loss history of the beacons received from the radio nodes in the subset.

27. (new) Beacon transmitting method according to of claim 26, further comprising a step of *storing* beacon parameters of the respective beacon messages.

28. (new) Beacon transmitting method according to claim 27, wherein the beacon parameters comprise at least one parameter relating to received signal strength of the beacon message, and at least one parameter relating to time of arrival of the beacon messages.

29. (new) Beacon transmitting method according to claims 15, wherein the step of estimating the network dynamics, the estimate of the network dynamics is at least partly based on the path loss history of the beacons received from the radio nodes in the subset.

30. (new) Beacon transmitting method according to claim 29, further comprising a step of *storing* beacon parameters of the respective beacon messages.

31. (new) Beacon transmitting method according to claim 30, wherein the beacon parameters comprise at least one parameter relating to received signal strength of the beacon message, and at least one parameter relating to time of arrival of the beacon messages.

32. (new) Beacon transmitting method according to claim 31, wherein the beacon parameters comprise parameters that have been included by the sending radio node in the beacon message.

33. (new) Beacon transmitting method according to claim 32, wherein at least one parameter originally included by the sending radio node comprises a parameters relating to the position of the sending node.

34. (new) A radio node adapted for communication in an ad hoc or multihop network, the radio node comprising and a transmitting part adapted to transmit

beacon messages and a receiving part adapted to receive beacon messages, the radio node comprising:

-beacon recording means for recording a plurality of beacon messages from a plurality of other radio nodes, and determining beacon parameters, the received beacon parameters comprising at least the respective received signal power and time of arrival of the received beacon messages;

-storing means for storing the received beacon parameters;

-statistical processing means for performing a statistical analysis on the stored plurality of beacon parameters, whereby producing an estimate of the network dynamics based on relative speed as compared to the radio node of each of the other radio nodes;

-beacon adjusting means for adjusting the transmission rate and/or power of transmitted beacon messages based on the estimate of the network dynamics.

35. (new) Radio node according to claim 34, wherein the statistical processing means estimates the network dynamics at least partly based on analysis of the relative speed of a plurality of neighbouring radio nodes and wherein the neighbouring radio node that exhibit the highest relative speed compared to the radio node, is given the greatest impact on the estimate of the network dynamics.

36. (new) Radio node according to claim 35, wherein the beacon receiving means is adapted to define a subset, NB_v, of neighbouring radio nodes, and the storing means is adapted to record and store received beacon parameters from at least another radio node which is part of the subset.

37. (new) A system of a plurality of radio nodes adapted to communicate in an ad hoc or multihop network, wherein the radio nodes transmits beacon messages (HELLO messages) between each other, at least two of the radio nodes of the

system comprising:

-beacon recording means for recording a plurality of beacon messages from a plurality of other radio nodes, and determining beacon parameters, the received beacon parameters comprising at least the respective received signal power and time of arrival of the received beacon messages;

-storing means for storing the received beacon parameters;

-statistical processing means for performing a statistical analysis on the stored plurality of beacon parameters, whereby producing an estimate of the network dynamics based on relative speed as compared to the radio node of each of the other radio nodes;

-beacon adjusting means for adjusting the transmission rate and/or power of transmitted beacon messages based on the estimate of the network dynamics.

38. (new) The system of radio nodes according to claim 37, wherein the statistical processing means estimate the network dynamics at least partly based on analysis of the relative speed of a plurality of neighbouring radio nodes and wherein the neighbouring radio node that exhibit the highest relative speed compared to the radio node, is given the greatest impact on the estimate of the network dynamics.

39. (new) The system of radio nodes according to claim 37, wherein the beacon receiving means are adapted to define a subset, NB_v, of neighbouring radio nodes, and the storing means are adapted to record and store received beacon parameters from at least another radio node which is part of the subset.

REMARKS

The claims have been amended to eliminate multiple dependent claims, without prejudice. The specification has been amended to include a cross-reference to the parent application and to add an Abstract of the Disclosure.

Respectfully submitted,

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ABSTRACT OF THE DISCLOSURE

The present invention relates to the use of beaconing or "hello" messages in wireless multihop or ad hoc communication networks. In the method according to the present invention beacon messages (HELLO messages) are transmitted between a plurality of radio nodes (205, 215) in an ad hoc or multihop network. The rate of which the radio nodes transmit their beacons is based on an estimate of the network dynamics. Also the transmit power of the beacons are preferably based on an estimate of the network dynamics. The radio nodes bases their estimate of the network dynamics on beacons received from neighboring radio nodes.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

LARSSON et al		Atty. Ref.:	4208-51
Serial No.	to be assigned	Group:	unknown
Filed:	February 9, 2007	Examiner:	unknown

For: METHOD AND ARRANGEMENT IN WIRELESS AD HOC OR MULTIHOP NETWORKS

* * * * * * * * * * *

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Sir:

INFORMATION DISCLOSURE STATEMENT

As suggested by 37 C.F.R. 1.97, the undersigned attorney brings to the attention of the Patent and Trademark Office the references listed on the attached form PTO-1449.

☐ All listed documents are attached.

☐ Copies of U.S. Patent Publications are not required and are not attached.

☐ Listed foreign patent publications and other documents are enclosed.

☐ The partial translations were provided to the undersigned by the applicants' foreign representative. The undersigned has no knowledge regarding the pertinency of the partially translated portions vis-á-vis the document as a whole. The partial translations are merely provided for whatever convenience they may be.

☒ The listed documents were cited in the ISR. Copies of the references will be filed at a later date.

This is not to be construed as a representation that a search has been made or that no better prior art exists, or that a reference is relevant merely because cited.

The Examiner is requested to initial the attached form PTO-1449 and to return a copy of the initialed document to the undersigned as an indication that the attached references have been considered and made of record.

The Commissioner is authorized to charge the undersigned's deposit account #14-1140 in whatever amount is necessary for entry of these papers and the continued pendency of the captioned application.

Respectfully submitted,
NIXON & VANDERHYE P.C.

February 9, 2007

By: [signature]
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INFORMATION DISCLOSURE CITATION

(Use several sheets if necessary)

ATTY. DOCKET NO.	SERIAL NO.
4208-51	to be assigned
APPLICANT	
LARSSON et al	
FILING DATE	GROUP
February 9, 2007	unknown

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
		2002/044533 A1	04/2002	BAHL et al.			

FOREIGN PATENT DOCUMENTS

		DOCUMENT	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO
		01/92992 A	12/2001	WO				
		01/73959	10/2001	WO				
		2004/023241 A	03/2004	WO				
		1 511 234 A	03/2005	EP				

OTHER DOCUMENTS (including Author, Title, Date, Pertinent pages, etc.)

		International Search Report of PCT/EP2004/014668, mailed 3 May 2005
		International Preliminary Report on Patentability of PCT/EP2004/014668 mailed December 5, 2005

*Examiner		Date Considered	

Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to application.

Form PTO-FB-A820 (Also PTO-1449)